(12) UK Patent Application (19) GB (11) 2 124 877 A

(21) Application No 8222789
(22) Date of filing 6 Aug 1982
(43) Application published 29 Feb 1984
(51) INT CL³ A01J 7/00
(52) Domestic classification A1M BA
(56) Documents cited GB 1488251 GB 1469761 GB 1451215 GB 1265636
(58) Field of search A1M
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(54) Monitoring milking

(57) Apparatus for use in monitoring milk flow comprises a set of teet cups (11-14), each connected to a manifold (15). The manifold is connected by conveying means (17) with a reservoir (18) for receiving milk. A pair of electrodes (28, 29) are disposed in an initial portion (19) of the flow path in the conveying means. A monitoring device (32) comprises means for applying an alternating voltage to the electrodes and for providing an electrical output signal representing the conductance of the circuit which includes the electrodes and the part of the milk flow path which lies therebetween. The output signal provides a measure of the rate of milk flow along the flow path. The device (32) can provide a signal for removing the teets.

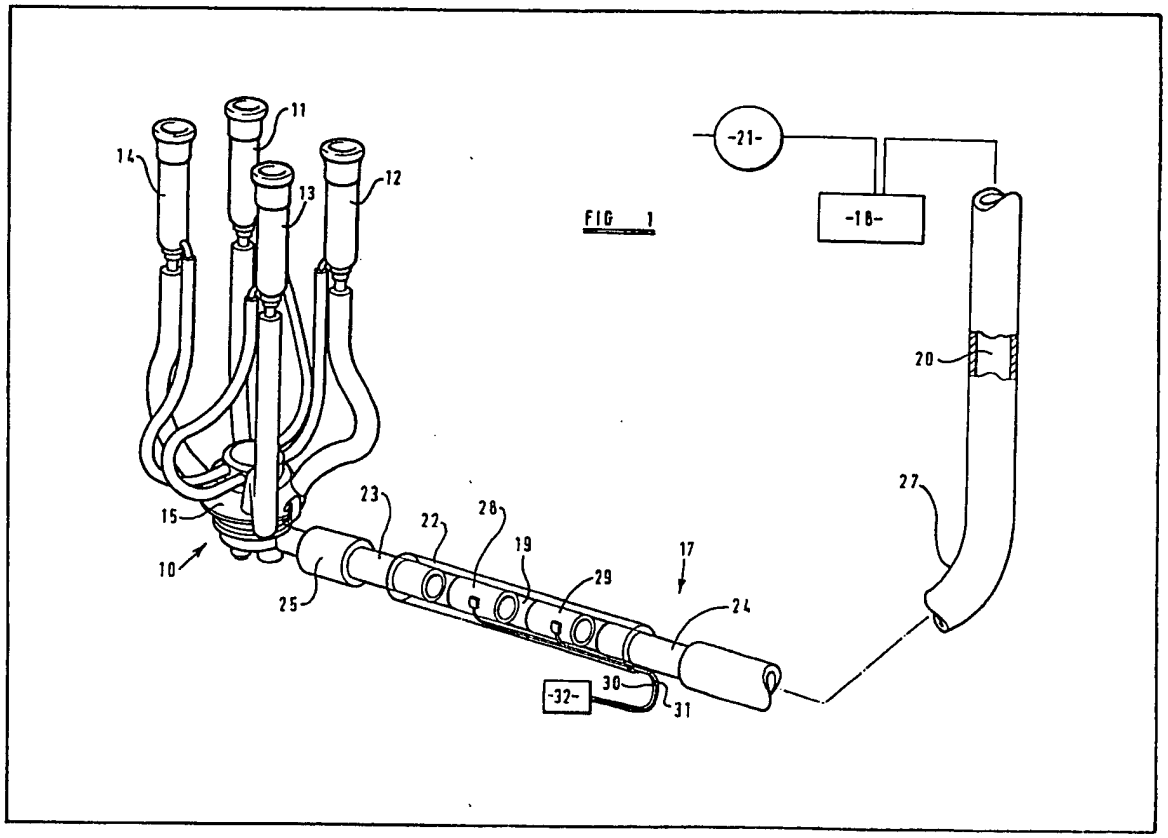

FIG 1

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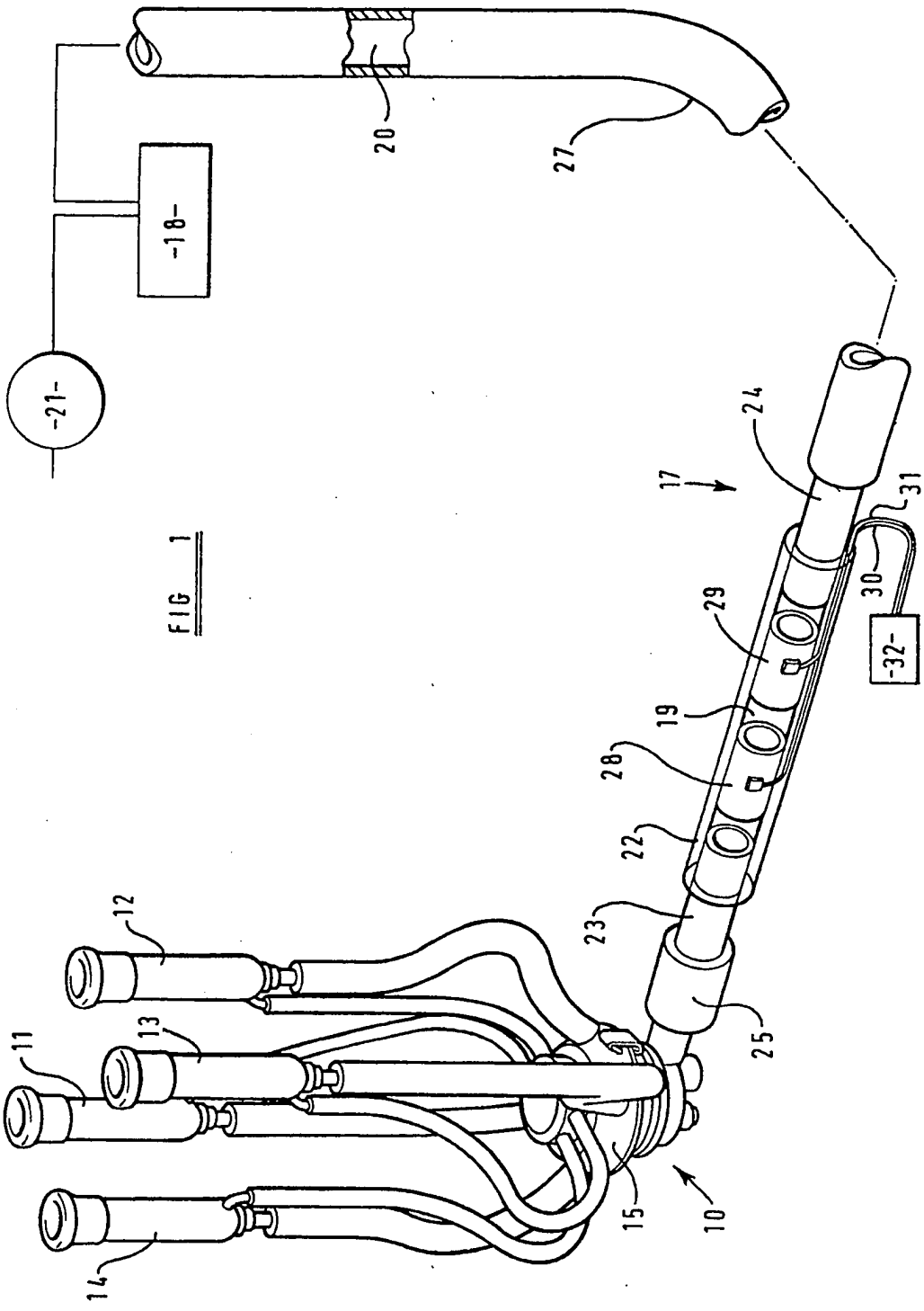
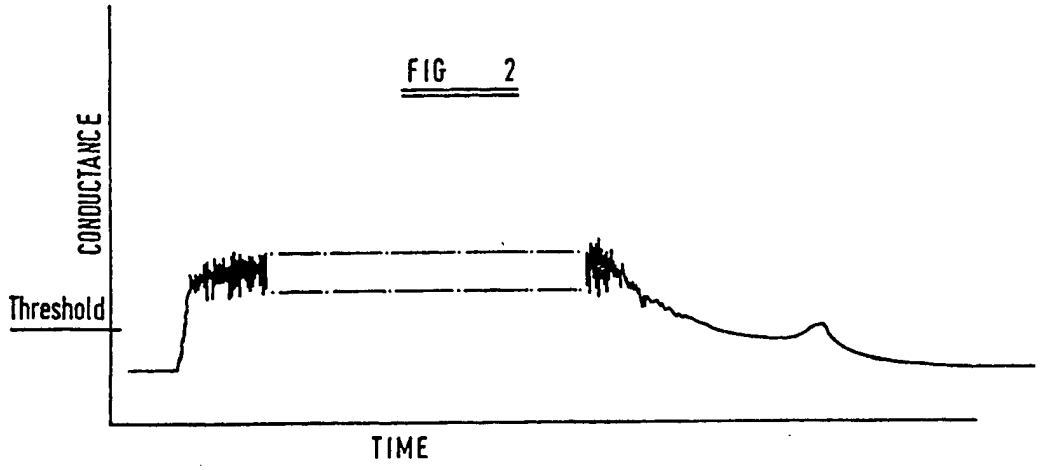


FIG 1

FIG 2



SPECIFICATION

Method of monitoring milking and apparatus for use in the method

This invention relates to a method of milking animals, primarily cows.

It is desirable to monitor the process of milking a cow by machine, in order to record or respond to changes in the rate of milk flow from the cow or other parameters and also to record or respond to the value of parameters at a particular time. For example, it is known to include in apparatus for milking cows devices which respond to the absence of substantial flow of milk from the cow by terminating the milking process and removing the teat cups from the teats of the cow. Known arrangements which respond to the absence of substantial flow of milk from the cow are unsatisfactory for a variety of reasons. One of these reasons is that the flow of milk through a position at which the presence of milk is sensed is erratic and not closely related to the flow of milk from the teats of the cow. These arrangements do not provide accurate information as to the flow from the teats.

According to a first aspect of the invention, there is provided a method of monitoring milking wherein milk discharged from a teat and air pass together along an initial portion and then a subsequent portion of a flow path, the milk and air in the subsequent portion of the flow path travelling upwardly, and wherein there is provided an output signal which is dependent on a physical property of the contents of said initial portion of the path.

Slugs of milk, each slug occupying the entire cross-sectional area of the path, are carried by the air up the subsequent portion of the path. The length of the slugs and the spacing between successive slugs varies in an unpredictable manner; whereas in the initial portion of the path the milk does not occupy the entire cross-sectional area of the path and the air present in the initial portion of the path lies above the milk. The respective proportions of the cross-section area of the initial portion of the flow path at a selected position are related in a reproducable manner to the rate of flow of milk along the initial portion of the flow path.

The physical property is preferably one which depends on the proportions of the initial portion of the flow path which are occupied by milk and air respectively. The property is preferably an electrical property.

In the preferred method, during a major part of the period for which a cow is milked, milk flows freely from the teats of the cow along the path and the amplitude of the output signal oscillates about a mean value with a frequency at which the teats are subjected to a cyclic pressure variation to induce flow of milk from the teats. When the amplitude of the oscillations of the output signal falls to a relatively low value, the mean value of the output signal is monitored and when the mean value then falls to a predetermined threshold, milking is terminated by allowing the pressure in the teat cups to rise to the ambient pressure and removing the teat cups from the cow.

According to a second aspect of the invention, there is provided apparatus for milking and comprising a manifold having an air inlet orifice, a set of teat cups connected with the manifold, a reservoir for storing milk, conveying means defining a flow path from the manifold to the reservoir and means for reducing the pressure in said reservoir to cause milk to flow from the teat cups through the manifold to the reservoir, wherein an initial portion of said path is more level than is a subsequent portion of the path and there is provided a plurality of spaced electrodes which present respective surfaces to the initial portion of the path, the electrodes being connected in an electric circuit with means for applying an alternating voltage to the electrodes and responding to variations in the conductance of the circuit to provide an output signal.

The electrodes preferably include a pair of electrodes spaced apart along the flow path.

There is also provided in accordance with the invention, for use in the method of the first aspect or in apparatus according to the second aspect, a tube of transparent, electrically insulating material having at opposite ends means for connecting the tube in a fluid flow line, having between its end portions a pair of tubular electrodes which are spaced apart along the tube and are embraced by the tube and having respective electrical conductors extending through a wall of the tube from the electrodes.

An example of a method and of apparatus embodying the invention will now be described, with reference to the accompanying drawings, wherein:—

FIGURE 1 shows the apparatus diagrammatically; and

FIGURE 2 represents an output signal of the apparatus.

The apparatus comprises a cluster 10 of known form comprising four teat cups 11 to 14, each connected by a pair of flexible tubes to a manifold 15. At the underside of the manifold, there is provided a valve which can be opened to admit air freely to the manifold and which normally defines a relatively small orifice through which air can enter the manifold. The manifold is connected by conveying means 17 with a reservoir 18 for receiving milk. This reservoir may be common to a number of clusters and may be remote.

The flow path defined by the conveying means 17 includes an initial portion 19 adjacent to the manifold 15 and a subsequent portion 20 which extends upwardly from the initial portion to a level above the teat cups 11 to 14. Generally, the subsequent portion 20 will extend to a level approximately two metres above the surface on which the cow being milked stands and, towards its upper end, the subsequent portion 20 will be substantially vertical. In contrast with this, the initial portion 19 is relatively level. Usually, the initial portion will slope downwardly from the manifold 15 towards the portion 20 but the initial portion may be substantially horizontal.

When the apparatus is in use, the teat cups 11 to 14 receive and act on the teats of the cow in the usual manner and air is drawn from the reservoir 18 by a pump 21 to maintain the pressure in the reservoir substantially below the ambient pressure. Milk which is discharged from the teats drains down to the manifold 15 and then along the initial portion 19 of the

path defined by the conveying means. Air enters the manifold through the air bleed orifice and also passes al ng the initial portion 19 of the path, where the air occupies an upper part of the path and the milk occupies a lower part.

The respective proportions of the cross-sectional area of the path occupied by the milk and air will vary along the initial portion 19 of the path and, at any selected position along the path, will depend upon a number of factors, including the geometry of the path, the rate at which air is admitted to the manifold and the rate at which milk is discharged from the teats of the cow. Intermittently, the milk occupies the entire cross-sectional area of the path at least at a position where the initial portion 19 merges with the subsequent portion 20 of the path. A slug of milk occupying th entire cross-sectional area of the path which is formed in this way is acted upon by the pressure within the initial portion 19 of the path or within the manifold 15. This pressure exceeds that in the reservoir 18 so that the slug of milk is driven up the portion 20 of the path to the reservoir. Air flows from the manifold through the initial portion 19 and up the portion 20 of the path behind the slug of milk until further milk accumulates in the initial portion 19 to occupy the entire cross-sectional area once more and form a second slug.

There is associated with the initial portion 19 of the flow path means for providing an output signal which is dependent on a physical property of the contents of the portion 19. The physical property is one which is different for milk and air, so that the value of the output signal will depend upon the respective proportions of the initial portion 19 occupied by milk and by air. The property is preferably an electrical property and, in the example illustrated, is conductance.

The initial portion 19 of the flow path is defined, in part, by a tube 22 formed of a transparent plastics material. There protrude from opposite end portions of this tube connectors 23 and 24 for connecting the tube respectively with the manifold 15 via a short length 25 of flexible tube and with a long flexible tube 27 which defines the subsequent portion 20 of the flow path. The connectors 23 and 24 may be formed of metal, for example stainless steel.

There is disposed within the tube 22 between the connectors 23 and 24 a pair of electrodes 28 and 29 which are spaced apart so that a part of the initial portion 19 of the flow path extends between them. In the particular example illustrated, each of the electrodes is of tubular form, defines the circumferential boundary of a part of the flow path and is tightly embraced by the tube 22. The electrodes are spaced apart along the flow path, typically by a distance of at least 10mm. Particularly in a case where the connectors 23 and 24 are formed of electrically conductive material, the electrodes 28 and 29 are spaced along the flow path from the connectors. The material of which the tube 22 is formed is an electrical insulator and is rigid, relative to the tube 27.

At least the electrode 28 which is nearer to the manifold 15 has a length which is at least twice the internal diameter of the electrodes. This diameter is typically 15mm. This electrode can be the connector 23. Electrically conductive leads 30 and 31 extend from the electrodes 28 and 29 respectively through the wall of the tube 22 to an electronic monitoring device 32 which may be mounted remotely from the tube 22. A suitable electrically conductive material from which the electrodes may be formed is stainless steel. If required, a larger number of electrodes may be provided and these may be spaced apart along the flow path or at least some electrodes may be spaced apart transversely of the flow path.

The monitoring device 32 comprises means for applying to the electrodes 28 and 29 an alternating voltage, typically having a peak value of three volts, and for providing an electrical output signal representing the conductance of the circuit which includes the electrodes 28 and 29 and the part of the milk flow path which lies between them. The electrode 28 is maintained at or close to earth potential.

A typical example of the electrical output signal during milking of a cow is represented in Figure 2. The teats of the cow are subjected to a cyclic pressure variation at a frequency which is typically one cycle per second. Usually, the flow of milk varies cyclically at the same frequency so that the depth of the layer of milk in the tube 22 increases and decreases with the same frequency and the value of the output signal varies in a corresponding manner. It can be seen in Figure 2 that, during the major part of the period which is represented the output signal oscillates about a mean value with a frequency in the region of one cycle per second. When the discharge of milk from the teats ceases or almost ceases, the amplitude of the oscillations of the output signal falls to a relatively small value. However, the mean value of the output signal does not fall immediately to a level indicating absence of milk from the flow path because a significant period elapses before all milk has drained from the tubes and manifold and has been carried to the reservoir 18.

It will be appreciated that, particularly when the rate of flow of milk is low, milk will tend to drain down the portion 20 of the flow path along the walls of the tube 22 without occupying the entire cross-sectional area of that tube so that the flow of air from the manifold 15 to the reservoir will not be very effective in transferring milk to the reservoir and a significant depth of milk may remain in the tube 22 after all flow from the teats of the cow has ceased.

The monitoring device 32 is adapted to respond to a significant fall in the amplitude of the oscillations of the output signal by commencing to monitor the mean value of the output signal. If, when the amplitude of the oscillations falls substantially, the mean value commences to fall and continues to fall to a predetermined threshold value, the monitoring device 32 provides a signal which initiates removal of the teat cups 11 to 14 mechanically from the teats of the cow by known equipment (not illustrated).

The monitoring device 32 is also adapted to respond in a different way, for example by providing a visual or audible warning signal, to other changes in the output signal. Examples of such other changes include significant fall in the amplitude of the oscillations about the mean value without the mean value then falling to the threshold value, a substantial change in the frequency of the oscillations about the mean value and a substantial change in the mean value without

substantial change in the oscillations about the mean value.

The monitoring device 32 may be adapted to delay by a predetermined period, for example 25 seconds, response to a change in the output signal, in order that a change which is reversed within a shorter period will not cause the monitoring device to respond. The monitoring device would normally be set in operation by the herdsman. For example, when automatic apparatus for removing the teat cups 11 to 14 is used, the herdsman operates an electrical switch to instruct that apparatus to release the teat cups in order that he can apply them to the cow. A signal from that switch may be passed to the monitoring device 32 to set the device in operation, after a predetermined delay, for example of 120 seconds.

CLAIMS

1. A method of monitoring milking wherein milk discharged from a teat and air pass together along an initial portion and then a subsequent portion of a flow path, the milk and air in the subsequent portion of the flow path travelling upwardly, and wherein there is provided an output signal which is dependent on a physical property of the contents of said initial portion of the path.

2. A method according to Claim 1 wherein the physical property depends on the proportions of the initial portion of the flow path which are occupied by the milk and air respectively.

3. A method according to Claim 2 wherein said physical property is an electrical property.

4. A method according to any preceding claim wherein milk discharged from a plurality of teats passes concurrently along the initial and subsequent portions of said path.

5. A method according to any preceding claim wherein, when the milk flows freely from the teat or teats along said path, the amplitude of the output signal oscillates about a mean value at a frequency at which the teat or teats are subjected to a cyclic pressure variation, when the amplitude of the oscillations of the output signal falls to a relatively low value, the mean value of the output signal is monitored and when the mean value then falls to a predetermined threshold, milking is terminated.

6. Apparatus comprising a manifold having an air inlet orifice, a set of teat cups connected with the manifold, a reservoir for storing milk, conveying means defining a flow path from the manifold to the reservoir and means for reducing the pressure in said reservoir to cause milk to flow along the path from the manifold to the reservoir, wherein an initial portion of said path is more level than is a subsequent portion of the path and there is provided a plurality of spaced electrodes which present respective surfaces to the initial portion of the path, the electrodes being connected in an electric circuit with means for applying an alternating voltage to the electrodes and responding to variations in the conductance of the circuit to provide an output signal.

7. Apparatus according to Claim 6 wherein the electrodes include a pair of electrodes spaced apart along the flow path.

8. Apparatus according to Claim 7 wherein that one of said pair of electrodes which is nearer to the manifold is a tube having a length of at least twice its internal diameter.

9. Apparatus according to any one of Claims 6 to 8 wherein the part of the conveying means which defines a space between the electrodes is transparent.

10. For use in apparatus according to any one of Claims 6 to 9 or in a method according to any one of Claims 1 to 5, a tube of transparent electrically insulating material having at opposite ends means for connecting the tube in a flow line, having between opposite end portions a pair of tubular electrodes which are spaced apart along the tube and are embraced by the tube and the tube having respective electrical conductors extending through a wall of the tube from the electrodes.

11. Apparatus substantially as herein described with reference to and as illustrated in Figure 1 of the accompanying drawings.

12. Any novel feature or novel combination of features disclosed herein or in the accompanying drawings.

Printed for Her Majesty's Stationery Office by The Tweeddale Press Ltd., Berwick-upon-Tweed, 1984.
Published at the Patent Office, 25 Southampton Buildings, London WC2A 1AY, from which copies may be obtained.